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(54) **Reducing vibration transmission through power plant and i c engine coolant chambers**

(57) Coolant chamber 34 contains gas, e.g. air, helium or exhaust gas, bubbles 36, foam spheres, gas filled sachets (38, Fig. 2) or a wall mounted layer (40, 42, 124, 224, Figs. 3 to 6) of closed-pore foam plastics which acts to suppress the transmission of vibrations through the coolant liquid to the chamber outer wall.

Fig. 1

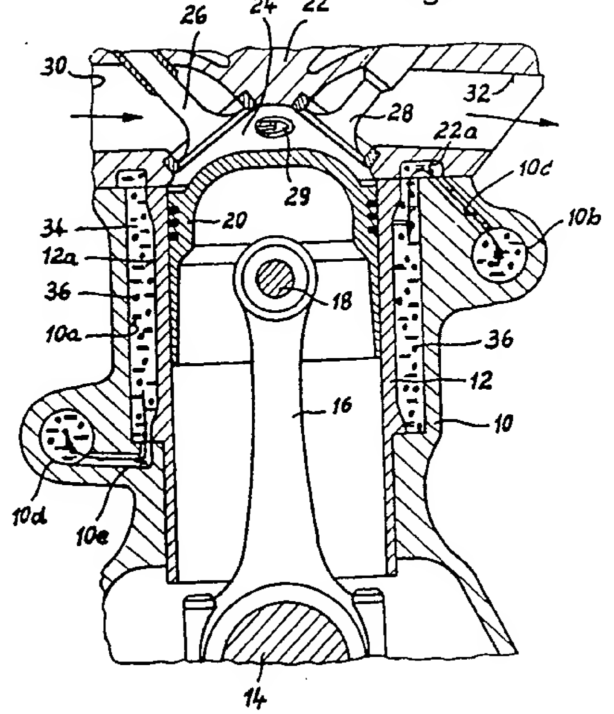

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Fig.1

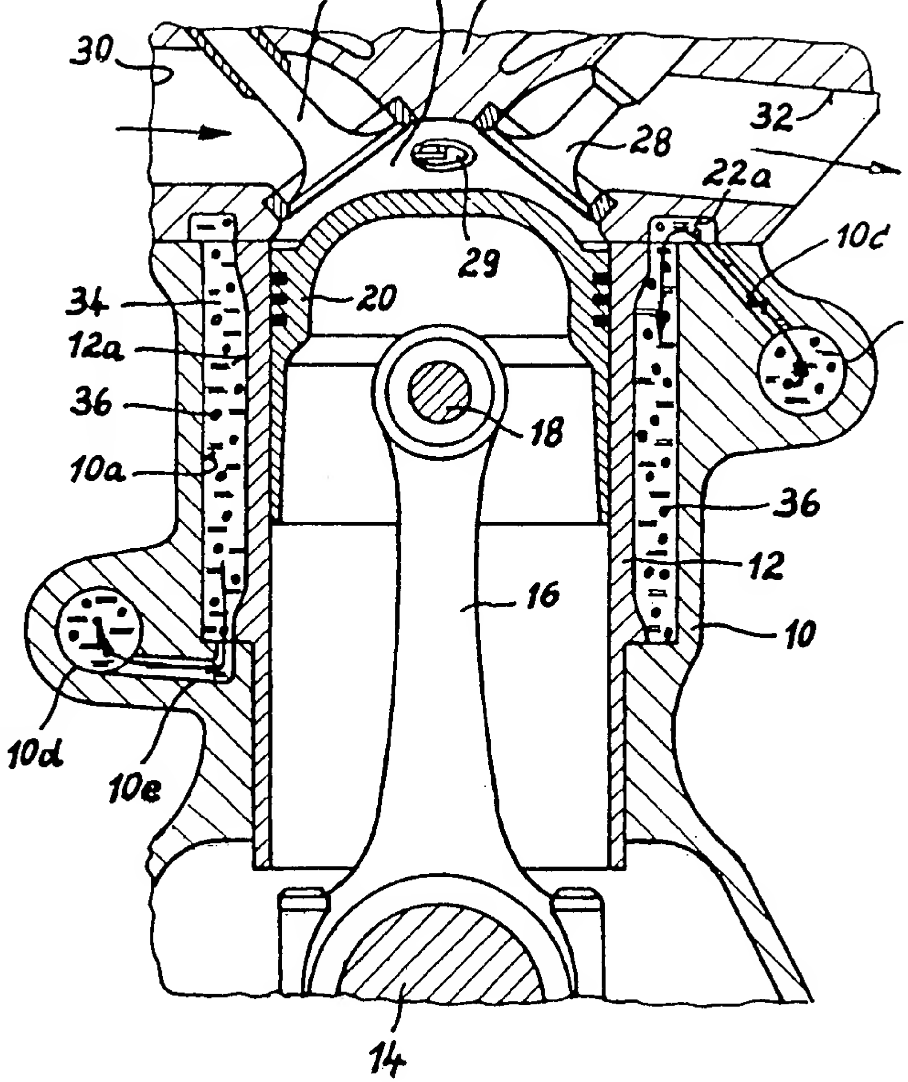

Fig.2

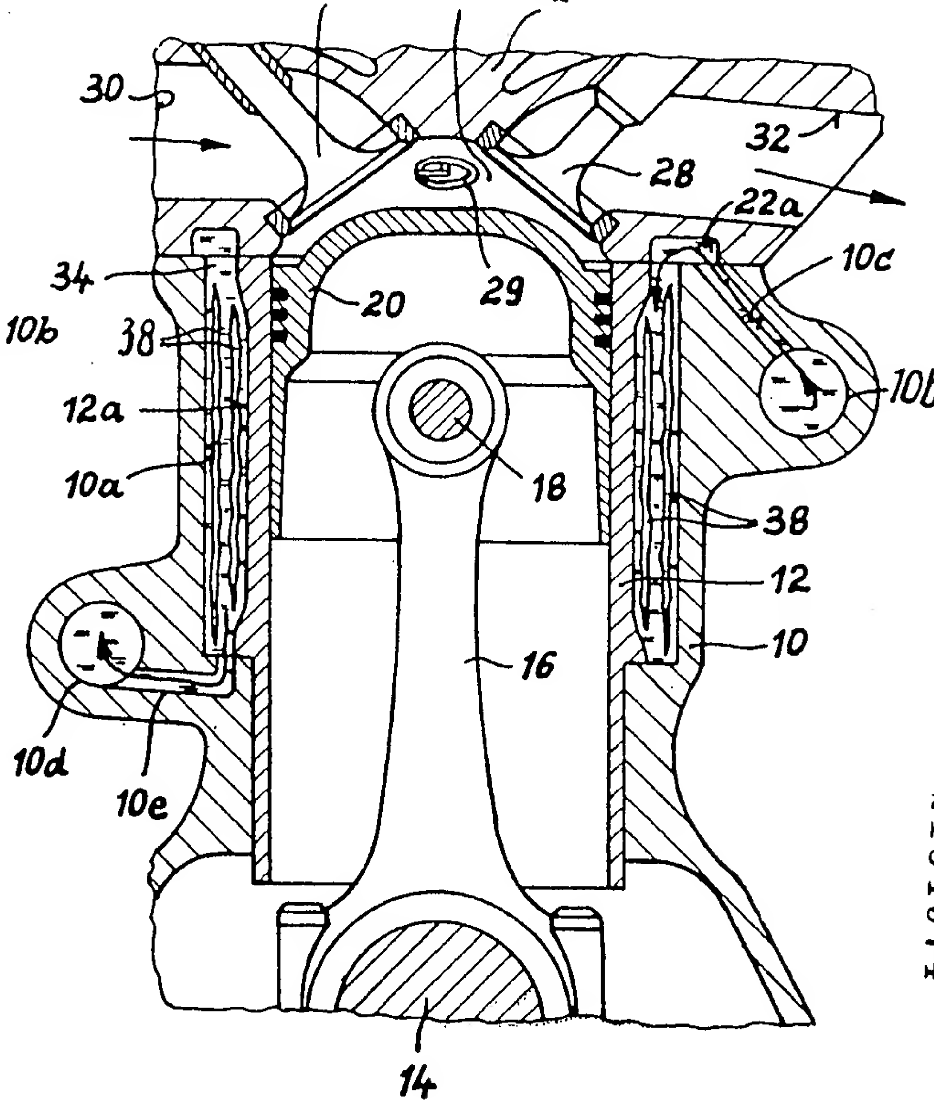

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Fig. 4

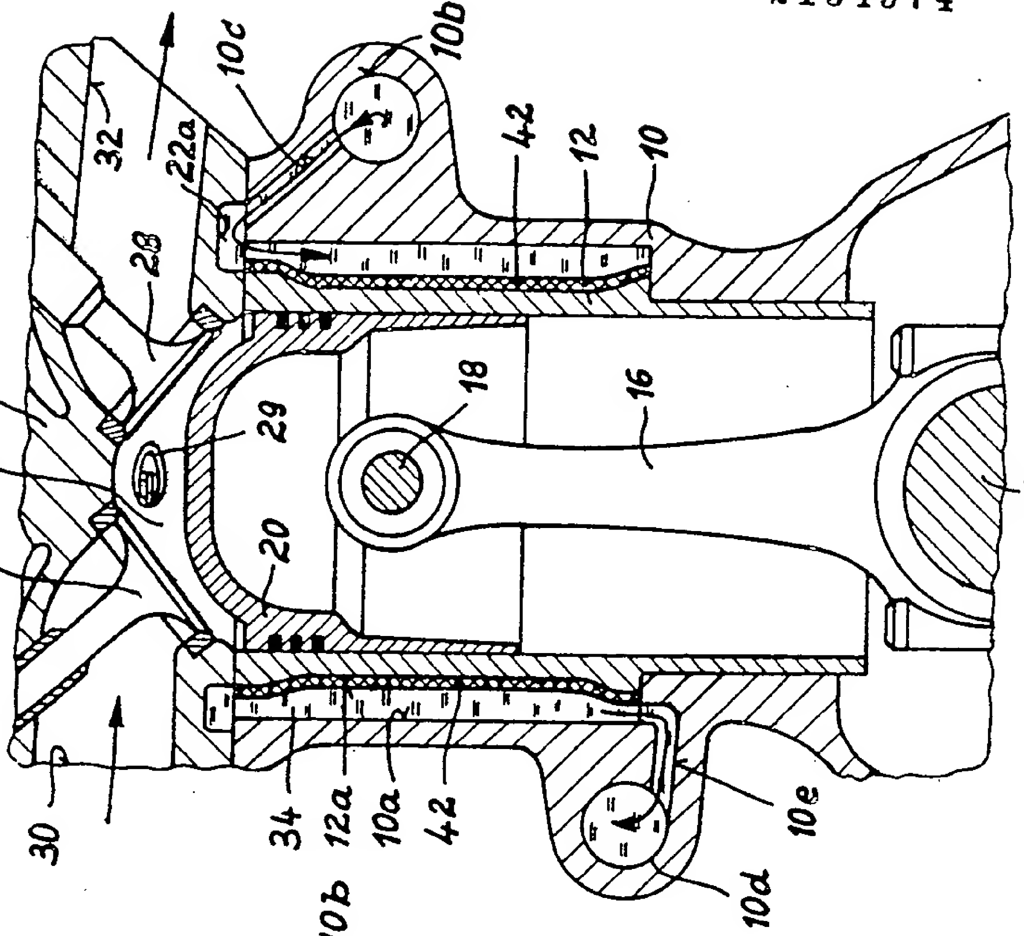
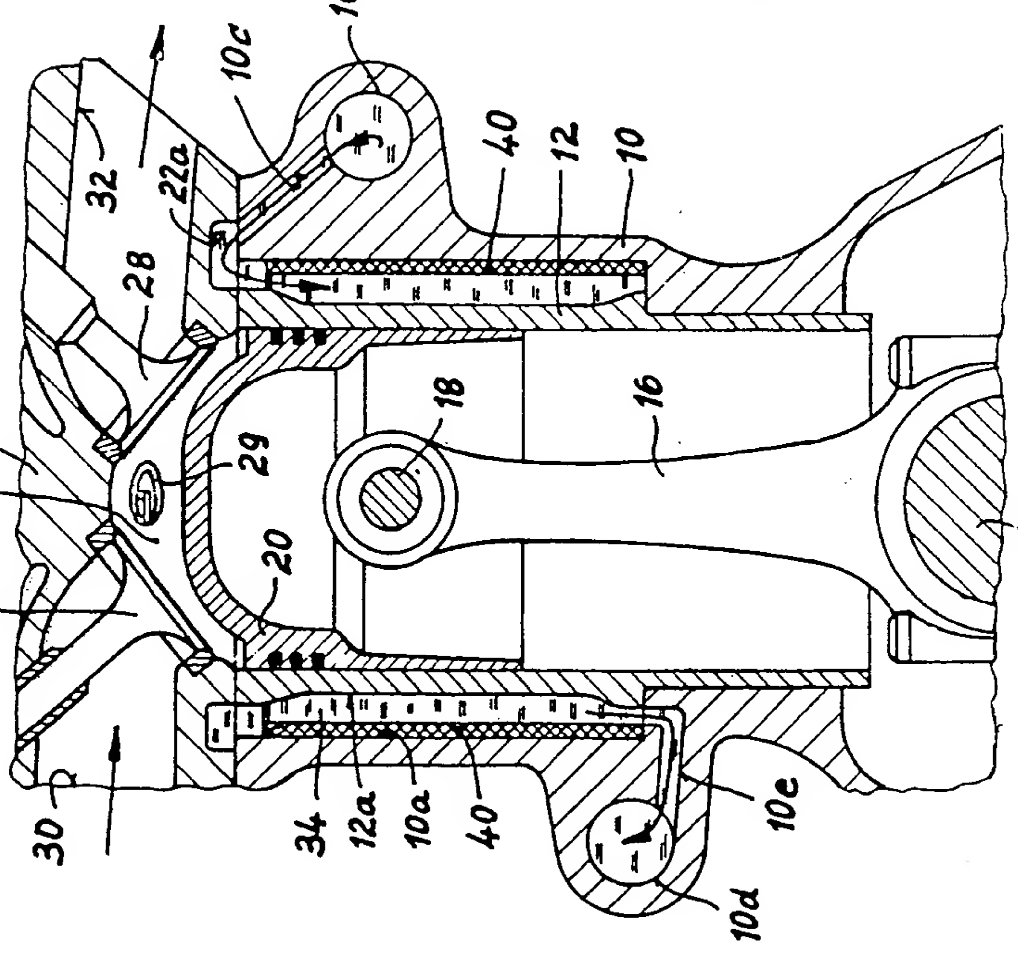


Fig. 3



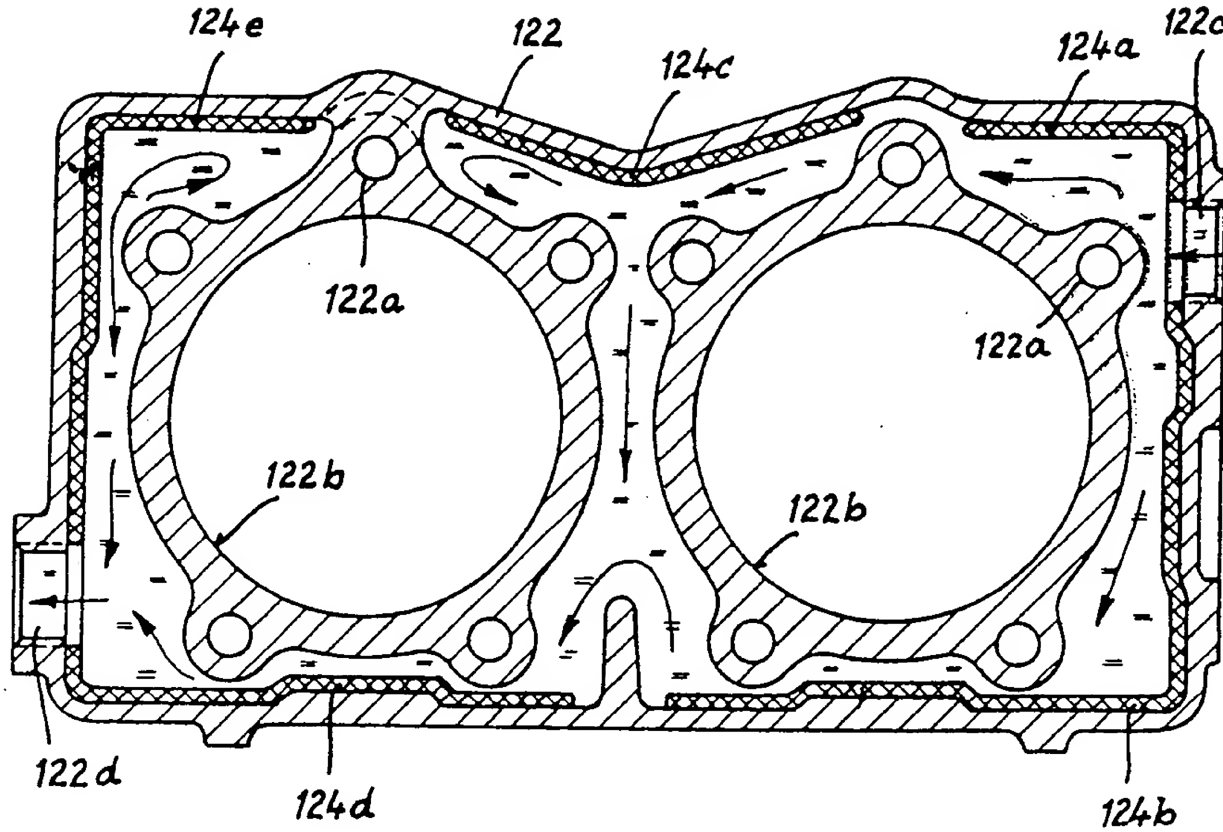

124e
122
124c
124a
122c
122a
122a
122b
122b
122d
124d
124b

Fig. 5

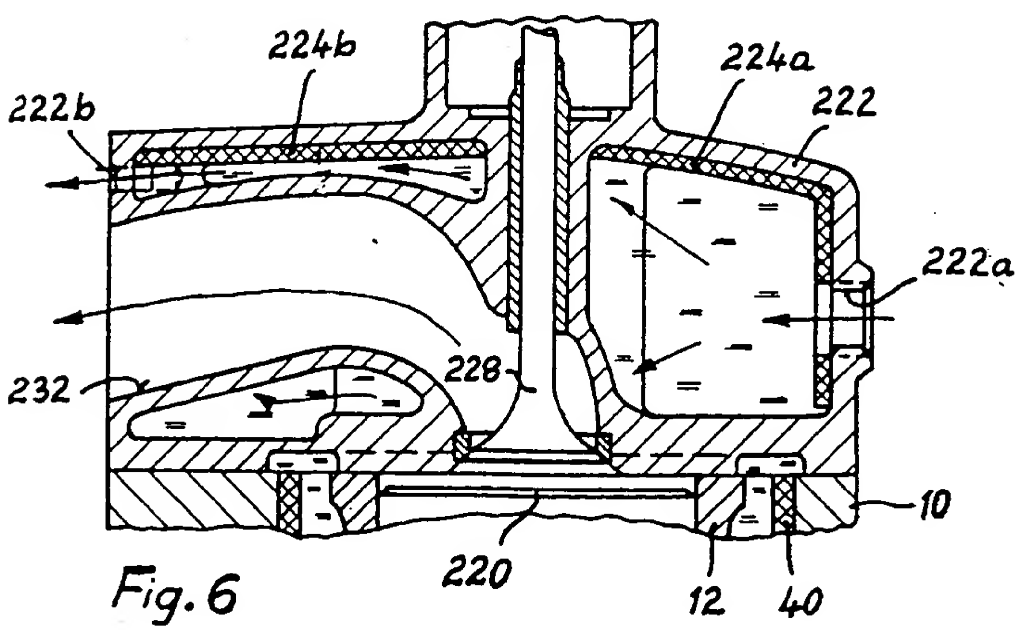

224b
222b
224a
222
222a
228
232
10
220
12
40

Fig. 6

SPECIFICATION

Liquid-cooling power plant or engine having vibration suppressing means

This invention relates to a power plant or engine having a casing with at least one internal wall which during operation of the power plant or engine is thermally stressed and subject to vibrations, and in which the power plant or engine has at least one hollow space between said internal wall and an outer wall of the casing in which space a liquid coolant is circulated to cool said internal wall. Mostly water or oil is used as a coolant in power plants or engines of this character. In practice it has been found prejudicial that the coolant in the aforesaid hollow space, although practically imcompressible, carries the vibrations developed during the operation of the power plant or engine directly to the outer walls of the engine casing there producing considerable noise emission. This phenomenon is noticeable in internal combustion engines particularly at the cylinder enclosing the combustion chamber or at the cylinder head containing the valves and the admission and exhaust ducts and here leads to a substantial build-up of noise in the vicinity of the engine.

It is an object of the present invention to circumvent these deficiencies in liquid-cooled power plants and engines and to bring about a substantial reduction in the amount of sound transferred through the layers of liquid coolant from the point of generation to the outer casing of the power plant or engine. This object is accomplished in the present invention by the fact that there is introduced into said hollow space at least one easily compressible means which by virtue of its inherent compressibility suppresses the vibrations induced during the engine operation in said inner wall and at least partially transmitted by the liquid coolant in such a way, that the transfer of these vibrations to said casing is reduced.

As the easily-compressible means use may be made, as a special feature of the invention, of a bubble-forming gas (for example helium) or gas mixture (for example air or exhaust gas) which is added to the coolant or mixed therewith. It is also possible to add small compressible, free-floating particles, for example of foamed material, to the coolant flowing in the aforementioned hollow space.

A further possibility within the invention is to introduce into the coolant liquid flowing through the hollow space elastic, free-floating sachets made from plastic foil and filled with a gas or gas mixture.

Another possibility is to spray one or both inner sides of the engine casing defining this hollow space with layers of fluent material which will swell to form compressible damping layers at least subsequently under the action of the coolant. Polyester or polyether could for example be the sprayed material.

Another embodiment of the invention resides in applying or attaching, and preferably cementing, to the inner and/or outer sides of the walls defining the hollow space layers of closed-pore, compressible foam material. Similarly and advantageously instead of one closed layer a plurality of segmented and mutually separated layers of suppressing material could be used, depending on prevailing working conditions.

Application of the deadening layers could, for example, take place during assembly by extrusion of layers, whereby such layers are foamed into slightly compressible condition at least subsequently by the action of the coolant.

A number of embodiments of the invention as applied to an internal combustion engine are described below with reference to the accompanying drawings. In these drawings:

Figure 1 is a longitudinal section through a water cooled internal combustion engine of known type, having vibration suppressing means introduced into the cooling water.

Figures 2 to 4 show internal combustion engines of a construction similar to that of Figure 1 but in each case with other forms of the vibration suppressing means introduced into the cooling water.

Figure 5 is a horizontal longitudinal section through the cylinder block of a water-cooled internal combustion engine with vibration suppressing layers in the hollow spaces for the cooling water, and

Figure 6 is a vertical cross-section through a water cooled cylinder head and likewise with vibration suppressing layers in the hollow spaces for the cooling water.

Illustrated in Figure 1 is an internal combustion engine of known type and operation. It includes a crankcase 10 in which is mounted an upstanding cylinder 12. The crankshaft 14 is disposed in the crankcase 10 is connected through a connecting rod 16 and a transverse bolt 18 to a piston 20 which is reciprocated up and down in the cylinder 12. The combustion chamber disposed between cylinder 12 and cylinder head 22 is designated 24. Provided in the cylinder head 22 are, in known fashion, a fuel admission valve 26, an exhaust valve 28 and an ignition plug 29 (or it could be an injector nozzle). The admission and exhaust ducts carry the references 30 and 32 respectively.

Defined between the inner side 10a of the crankcase 10 and the outer side 12a of cylinder 12 is an annular hollow space 34 of appropriate dimensions through which flows liquid coolant, in the present instance cooling water. The cooling water enters through an inlet 10b under the action of a feed pump of known form (not shown) and flows through a hole 10c into an annular chamber 22a at the underside of the cylinder head 22 and hence into the hollow space 34. A return conduit 10e and an outlet connection 10d are used to return the cooling water to a suitable (likewise not shown) arrangement where the heated cooling water is recooled. From here the coolant water is sent by the feed pump previously mentioned into the cooling chanber in the internal combustion engine.

The cooling water within the cooling system is mixed, in the present invention, with a readily-compressible medium, in the case illustrated air, to generate a plurality of air bubbles 36 in the cooling system. A mixture to a suitable water-air proportion is made before the engine is started and is controlled for a preset running period.

In this way the freely floating air bubbles 36 are

carried along with the circulating cooling water and compressed by the vibrations within this water and as a result of the compression applied thereto suppress to a substantial degree the transmission of the vibrations emitted by the cylinder 12 through the cooling water layer to the crank-case 10 and thus to the outer jacket of the internal combustion engine. Undesirable noise stresses in the environment of the internal combustion engine are thereby considerably reduced.

Instead of adding an air-mixture to the coolant other gases, for example helium or some other gas mixture (for example exhaust gases), can be mixed in.

Another method of vibration-suppression is possible by adding to the coolant of the engine small compressible freely-floating particles, for example small spheres of foamed material, which would have a damping effect similar to that of air bubbles.

Figure 2 illustrates another aspect of the invention. Here a plurality of resilient plastic foil sachets 38 are used, filled with air or some other gas or gas mixture and then closed. The individually closed sachets 38 are introduced into the hollow space 34 during assembly of the engine so that after the introduction of cooling water into the hollow space 34 they float freely. As a result of the inherent compression of the sachets 38 there is a damping effect similar to that of the construction described in connection with Figure 1 when the vibrations occur.

The embodiment of Figure 3 illustrates another form of suppression means. Here a sleeve-form layer 40 of closed-pore foam material is attached to the inner side 10a of the crankcase 10, for example is cemented thereto. As a result of its inherent compressibility this layer 40 also damps the transmission of the vibrations from cylinder 12 through the cooling water layer to the crankcase 10 and also in this way reduces an excessive creation of noise in the vicinity of the internal combustion engine.

A further embodiment in Figure 4 shows that a vibration suppressing layer of foam material 42 can be applied to the outside of cylinder 12, this producing a damping effect analogous to that of layer 40 of Figure 3. It is to be undestood that the cooling water need not act directly on the cylinder 12 in a construction of this nature in which event there will be a minor reduction in the cooling effect. A constructional assembly of this nature will therefore only be used in internal combustion engines in which the cylinder is not subject to heavy thermal stress and thus where only a modest cooling effect is required.

The embodiments described can be used with both single- and multi-cylinder internal combustion engines. They can also be used with Otto-engines such as Diesel engines or with rotary piston engines. The embodiments described can also be used where there is oil cooling or other liquid cooling.

Figure 5 is a plan view of a horizontal cross section through a cylinder block 122 of a water-cooled two-cylinder internal combustion engine with upright cylinders. Holes 122a in the block 122 permit the passage of fastening screws to connect the cylinder block 122 and the cylinder head (not here shown) to the crankcase of the machine. Two piston chambers 122b can also be seen. Above the piston chambers are the inlet and discharge valves (not shown) as well as the inlet and exhaust conduits within the cylinder head.

Connection threads 122c and 122d for cooling water inlet and discharge conduits are provided on the block 122. The insides of the outer walls of the cooling chamber hollow spaces within the cylinder blocks 122 are lined with a plurality of mutually separated layers 124a and 124e of closed-pore foam plastics material, for example these being cemented to the associated walls. These have the same damping effect as the layers 40 and 42 of the Figures 3 and 4.

Figure 6 is a cross-section through a cylinder head 222. The exhaust valve 228 is disposed above the piston 220, movable in the cylinder 12, and the exhaust conduit is designated with the reference numberal 232. The cylinder head 222 is connected to a cooling water system, for which purpose an inlet 222a and an outlet 222b with appropriately threaded openings are provided. The outer walls of the cooling water hollow spaces in the head 222 are again lined (for example by cementing) with vibration damping foam plastic layers 224a and 224b.

Layers of foam material which always have a constant degree of compressibility in any condition can be used. It is however also possible to bring the layers in dry condition to the associated walls and convert them into slightly compressible damping layers at least subsequently under the action of the coolant media.

Further, fluent material layers could be sprayed on to the walls and subsequently formed into compressible damping layers at least subsequently by the action of the coolant. There is no difficulty in adapting the thickness of a layer at any time to the appropriate prevailing conditions. Their application during assembly in accordance with the type employed presents no problems.

It should also be stated that in the case of the constructions of Figures 5 and 6 the damping means described in connection with Figures 1 and 2 could optionally also be used. Finally it is noted that the damping means which have been described in connection with the cooling system of an internal combustion engine could be used for other power aggregates or engines of a similar nature, for example with liquid-cooled compressors.

CLAIMS

1. A power plant or engine having a casing with at least one internal wall which during operation of the power plant or engine is thermally stressed and subject to vibrations, and in which the power plant or engine has at least one hollow space between said internal wall and an outer wall of the casing in which space a liquid coolant is circulated to cool said internal wall, wherein there is introduced into said hollow space at least one easily compressible means which by virtue of inherent compressibility suppresses the vibrations induced during engine operation in said inner wall and at least partially transmitted by the liquid coolant in such a way that the transfer of these vibrations to said casing is reduced.

2. A power plant or engine, according to claim 1,

wherein a bubble-forming gas or gas mixture is added to the liquid coolant flowing through the hollow space.

3. A power plant or engine according to claim 1, wherein small, compressible, free-floating particles are added to the liquid coolant flowing through the hollow space.

4. A power plant or engine according to Claim 1, wherein elastic, free-floating foil sachets filled with gas or gas mixture are added to the liquid coolant flowing through the hollow space.

5. A power plant or engine according to Claim 1, wherein fluent material layers are sprayed during assembly on at least one inner side of the walls defining said hollow space and are swollen at least subsequently by the action of the liquid coolant to form layers of compressible vibration-deadening material.

6. A power plant or engine according to claim 1, wherein layers of closed-pore compressible foamed material are loosely added or secured, for example cemented, to at least one internal side of the walls defining the hollow space.

7. A power plant or engine according to claim 1 in the form of a water- or oil-cooled internal combustion engine having working pistons, whereby cylinder guiding each such piston and at least partially defining the combustion chamber is subjected to high thermal stress and enclosed by a hollow space connected to a circulatory cooling system, wherein at least one layer of closed-pore compressible foamed material is attached, preferably cemented, to at least one internal side of the walls defining said hollow space.

8. An internal combustion engine according to claim 7, wherein the layer is attached to the inner wall of the engine.

9. An internal combustion engine according to claim 7, wherein the layer is secured to the outer side of the cylinder.

10. An internal combustion engine according to one of claims 7 to 9, wherein the layer has the form of a closed ring which is mounted concentrically on the cylinder.

11. A power plant or engine according to claim 1 in the form of a water - or oil-cooled internal combustion engine, the thermally highly stressed cylinder head of which, containing the valves and the admission and exhaust ducts, has hollow spaces connected to a circulatory cooling system, wherein a layer of closed-pore foamed material is secured, for example cemented, to the inner sides of the walls of the cylinder head defining said hollow spaces.

12. An internal combustion engine according to claim 11, wherein a plurality of mutually separated segments of foamed material are secured to the insides of the cylinder head.

13. An internal combustion engine according to one of claims 7 to 11, wherein the foamed material layers are applied in dry condition to the associated walls and foamed into lightly compressible condition at least subsequently under the action of the liquid coolant.

14. An internal combustion engine arranged and adapted to operate substantially as hereinbefore described with reference to the drawings.

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